



INL has partnered with Baard Energy to design one of the nation's first coal-to-liquids plants, a project that could help power the U.S. transportation system without relying on foreign oil.

A wealth of liquid fuel right under our feet

by [Roberta Kwok](#), *Research Communications Fellow*

Buried in wide swaths across the United States are billions of tons of coal reserves that the nation has long tapped to generate electricity. But with the resurgence of a nearly century-old technology, these lumps of coal could soon have a new use: providing gallons of synthetic fuel to power our cars, trucks and planes.

The method is called coal-to-liquids, and it can transform coal into high-energy fuels such as gasoline and diesel. In the past, the technique was used only by countries with few energy options. Now, Washington-based Baard Energy has partnered with Idaho National Laboratory to design one of the nation's first coal-to-liquids plants, a project that could help power the U.S. transportation system without relying on foreign oil. INL researchers are helping Baard devise more efficient models for the plant and investigating approaches to make this carbon-intensive process emit fewer greenhouse gases.

Creating synthetic liquid fuel relies on a set of chemical reactions called the Fischer-Tropsch process, invented by German scientists back in the 1920s. Germany used the technology during World War II to convert coal into diesel for its tanks. Later, South Africa -- cut off from the world's oil supplies because of its apartheid policy -- built a few commercial coal-to-liquids plants. But other countries have historically been loath to adopt the Fischer-Tropsch method because of the high cost compared to imported fuel from the Middle East.

Now, with unstable gas prices, a shrinking oil supply and national security concerns at the forefront, companies are taking a second look at coal-to-liquid fuels technology. "It's definitely not new, but people are realizing that we're short on oil, and this is a method that will work," says INL engineer Rick Wood. "For energy security reasons, we want to look to other resources."

One such company, Baard Energy, plans to build a \$5 billion Fischer-Tropsch plant in Ohio. The plant will produce 53,000 barrels per day of synthetic diesel and jet fuel, which will be able to power today's trucks and planes after being treated with additives or blended with traditional fuel. Under a cooperative agreement, Baard and researchers from the U.S. Department of Energy's INL are studying and refining the coal-to-liquids process. With INL's help, Baard received its final environmental permit in November and is scheduled to open the plant in late 2012.



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overall energy output of the plant.

"INL's input was critical," says Baard Energy President John Baardson, adding that the INL team performed many of the engineering calculations required for the permit application. INL has unique modeling capabilities in this arena.

As part of their work for Baard, INL researchers have built computer models of the entire coal-to-liquids system. The process is complex: The coal must first be heated to 2,500-2,800 degrees Fahrenheit and partially burned to "gasify" the rock into hydrogen and carbon monoxide. The gases are then fed through a bed of iron or cobalt catalyst molecules that jump-start a chemical reaction. The reaction produces long carbon-hydrogen chains that can be refined into synthetic fuel or other chemical products.

By modeling the plant from front to back, the INL team can find ways to make the process more efficient. For example, the researchers have examined methods for capturing steam and other gases from the Fischer-Tropsch reaction to power turbines, which could generate electricity and boost the



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But coal-to-liquids technology still faces a major criticism: its relatively high greenhouse gas emissions. To produce the amount of hydrogen needed

to make the liquid fuel, the plant combines water and carbon monoxide, a step that generates carbon dioxide as a byproduct. And some operations, such as refining the synthetic fuel, require fired heaters that burn gas and release more carbon dioxide.

So INL researchers are studying ways to shrink the plant's carbon footprint, such as capturing and sequestering carbon dioxide emissions underground. The team also helped Baard figure out more efficient ways to gasify biomass, in addition to coal, to produce the initial hydrogen and carbon monoxide. With carbon sequestration and biomass usage factored in, manufacturing synthetic fuel actually results in lower carbon dioxide emissions than conventional petroleum fuel production, Wood says. And under a congressionally-funded project, INL is continuing to explore strategies to reduce or reuse carbon dioxide sources throughout the plant.

"The combination of biomass with coal takes advantage of the carbon credits given to biomass with the economies of abundant coal in the U.S.," says INL engineer Richard Boardman, who worked with Wood and engineer Anastasia Gribik on the project. "Many say we should kill new coal projects, but I believe we should do more to understand improved methods to use this abundant natural resource without disregarding the environment."

In addition to collaborating with Baard Energy, the INL team is modeling similar technology for the coal-rich state of Wyoming and about a dozen other companies. Some companies are interested in converting coal to products such as methanol or ammonia, which are heavily used by the chemicals industry. Other INL groups are investigating the possibility of using a different reaction to supply the extra hydrogen, a system that would reduce carbon emissions even further if it were powered by the heat from a nuclear plant.

Although today's low gas prices may have temporarily weakened the financial incentive for synthetic fuel production, Wood says these projects are important for the U.S. to assert its energy independence. "From an energy security standpoint, they make as much sense as they ever have," he says. "We have to get rid of our dependence on the Middle East for our energy."

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Biomass could also be gasified to produce the initial hydrogen and carbon monoxide needed to make synthetic liquid fuel.